

First resume of the new international Master of Science in Cartography

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Abstract. The joint Master of Science in Cartography, a co-operation between three technical universities, Technical University of Munich, Germany (TUM), Technical University of Dresden, Germany (TU Dresden), Germany, and Technical University of Vienna (TU Vienna), Austria, was established in 2011. The new international Master program "Cartography" aims at educating highly qualified scientists in cartography and cartography-related academic fields. The curriculum is constructed following international standards in terms of a quality management system covering the whole process from student selection to the supervision of thesis work. It is unique due to its focus on cartography and its status as the first English language program in German speaking countries. The final qualification is a "joint degree" from the participating universities TUM, TU Dresden and TU Vienna, each contributing to the program with an equal amount of credit points. In this paper we would like to share our experiences gained from the first 1,5 years since the program was introduced. Furthermore we will highlight the program features, the added values, participants' statistics, and an overview of students' feedback.

Keywords: Cartography, Geoinformation, Education, University master program

1. Background

On February 15th 2008, 14 renowned professors from the cartography departments of German, Austrian and Swiss universities met in Munich to discuss the possibilities of how to respond to the growing demand on professional cartographers or cartographic competence and how to harness the dramatic quality drop and ethical concerns associated with in the huge quantity of modern maps in the ubiquitous Internet and the mobile society. The meeting led to the consensus of jointly establishing an international Master of Cartography in Europe. From 2008 to 2010 further intensive communications took place in the cartographic community in Central Europe, followed by a comprehensive demand analysis. Finally TUM, TU Vienna and TU Dresden decided to set up the curriculum of a new international Cartography Master program targeted to international learners who seek in-depth cartographic knowledge for their career or planned career for which mapmaking and map use play a significant role. Upon starting the first round of the Master program, the Faculty ITC of University of Twente became involved in the program in terms of co-supervising Master theses and thus it brings additional expertise to the program as well as a strong contribution to a higher level of internationalization of teaching staff. The establishment and in particular the demand of a new international Master in Cartography has been presented on altogether 7 international conferences, and published in 2 conference papers and 3 journal paper so far (Koch et al. 2010; Krisp et al. 2011; Krisp et al. 2009; Peters et al. 2009; Peters et al. 2010)

The Master program is named as “Cartography” – a seemingly counteraction to the two mainstreams we observed in the international cartographic community: On the one hand, cartography as a well-established discipline is diversified and somewhat equalized with some modern terms such as geovisualization or spatial visualization. On the other hand, many cartographic journals or book series worldwide tend to couple cartography with the emerging discipline of geoinformatics or delimit the application of cartographic methods within geoinformation. It is true that the cartographic profession has been refreshed and reshaped many times with the rapid technical development. Both mainstreams have injected new vitality to cartography, thus made substantial contribution to the pervasiveness of maps. However, they have also diluted the identity of cartography as an independent discipline and stirred up certain confusions among professional cartographers.

In fact, the first generation of GIS was essentially characterized by computer-aided mapping systems, leading to the misinterpretation of cartography as a branch embedded in the broader geoinformation engineering or

geoinformation science. This perspective has largely ignored the soft part of cartography as a designing art for which an entire automation of map design is neither possible nor necessary. However, if we treat cartography as a pure art and try to maximize the aesthetic value of maps, we then run the risk of abandoning the scientific value of maps as storage medium, communication language and exploration instrument of geoinformation for various user groups and their various purposes. On this note, we feel obliged to revisit the cartographic discipline by means of the international Master program and define its disciplinary core with independent cartographic fundamentals as well as its interdisciplinary connections, e.g. to geoinformatics at one end and to cognitive sciences at the other end. We expect students enrolled to the program to have a good command of both disciplinary and interdisciplinary skills anchored in cartography by the time when they accomplish the academic degree.

2. General program features and concepts

2.1. Program goals

The main goal of the Master of Science in Cartography is to spearhead the cartographic education and research not only in Europe but also worldwide. The program aims to educate excellent students from all over the world to become future engineers and researchers in cartography-related disciplines and to prepare them either for a career in the scientific or in the industrial field of cartography. Facing the challenges of modern cartography as an interdisciplinary area, graduates will be prepared to design cartographic tools to analyze and visualize our rapidly changing world. Moreover, the program provides students with the necessary skills to prepare them for doctoral studies on a European level. Thanks to the strategic partnerships of this program, a role model in international cartography education and research shall be established and transferred to other study programs of the participating universities (and respective faculties and institutes). Another goal is to improve the mobility of students and scientists worldwide and likewise encourage the mobility of scientific and administrative staff to strengthen the collaboration between the consortium members. With its unique features, this innovative and sustainable program will guarantee excellent job opportunities. The program aims to educate 15 to 20 excellent students per year.

2.2. Added values

The Cartography MSc is a new Master of Science in Cartography in Europe which, moreover, is offered totally in the English language. Through the

cooperation of 3 leading universities in the field of cartography the combined comprehensive expertise enables a unique curriculum and provides an exceptional program with excellent job employment prospects. This joint master provides a complementary and multifaceted 'cartographic' teaching environment.

The added value of this specific course is that it is a pioneer for picking up the importance of an interdisciplinary approach in a domain of growing importance. Modern Cartography needs experts with skills and knowledge in various backgrounds ranging from computer science to cognitive sciences. This expertise is relevant and significantly needed in the growing domain of Geo Spatial Information Management. The program focuses on research questions that were hardly studied before, such as spatio-temporal data integration for mapping purpose, location-base map services, personalized map design and user research etc.

2.3. Program structure

The Cartography MSc takes place at 3 universities. Students have to spend their 1st semester at TUM in Germany. Then they have to study the 2nd semester at TU Vienna in Austria. After that they study their 3rd semester at TU Dresden in Germany. During the 4th semester students prepare their Master's Thesis at one of the 3 participating universities. Furthermore the University of Twente in The Netherlands is a cooperation partner for Master's Thesis supervision. The program awards a total of 120 ECTS and is to be completed in two years. Students obtain 30 ECTS in each semester/ at each university, respectively 30 ECTS for their Master's Thesis. The qualification finally awarded to the students is a joint degree, issued by TUM, TU Vienna and TU Dresden together. TUM as the leading university is in charge for the management of application procedure and for generating of the final degree documents. Our program is conceptualized with a fixed structure. Students stay together as a group during the whole time. Thus the aim is that a stronger motivation, affiliation and identification with the program shall be developed.

Master's Programme in Cartography			Credits	Semester
Cartographic Foundations Scientific Visualization	Geostatistics Geovisualization	Image processing, Photo- grammetry & Remote Sensing	30	1 (TUM)
Theoretical Cartography Cartographic Interfaces	Location Based Services Multimedia Cartography	Cartographic publishing, Web- mapping, Geomedia Techniques	30	2 (TU Vienna)
Mobile Cartography Geodata Generalization	Georelief and Cartography GIS Applications	True-3D, Dynamic Geo-Features Radar Cartography	30	3 (TU Dresden)
Master's Thesis preparation (at one of the 3 cooperating universities)			30	4

Figure 1. Program structure and contents

2.4. Program contents

The program focuses on a comprehensive education in cartography and geoinformatics, in particular on spatial information technologies, mathematical principles of map making, spatial data handling, theories and technologies of visual analytics, geovisualization and communication of spatial information. Besides performing practical and development tasks in the fields related to cartography and geoinformatics, students are supposed to be trained for taking part in research projects and aim for continuation of their studies to gain a PhD. Teaching is research oriented. The program provides a link between research, theory and practice, whereby the scientific theoretical part in the program involves the teaching of applied cartography. An academic flexibility is given through elective modules. Figure 1 gives an overview about the program structure and its contents.

2.5. Financial aspects

Finances usually are one of the biggest concerns of the students. The tuition fee for the entire program is 500,- Euro. This is quite attractive; nevertheless living costs are quite expensive, in particular in Munich and Vienna. Also the required program mobility makes it more difficult for students to find a job besides studying. The program committee is currently constructing and applying for an Erasmus Mundus scholarship.

2.6. Re-examinations

Re-examinations of most of the modules can be done in the same semester already. If not possible, the consortium enables remote distance re-examinations. These are held in written form at the end of the following semester at the university the student moved to. The coordinator organizes the prompt execution of the exam and then returns the completed exam for evaluation to the local coordinator of the university where the original examination was held in the previous semester. This mechanism had been already applied successfully in the running program.

2.7. Mobility challenge

In the unlikely case that a student cannot continue the program directly after semester 1 (TUM) and move onto semester 2 (TU Vienna), the student does not have to interrupt the program for one full year. In that case, the student can move at the following winter semester to TU Dresden and catch up the „missing” semester at TU Vienna afterwards. In such cases, it is possible that a student studies as follows: TUM (winter semester) – break (internship / repeating exams) – TU Dresden (winter semester) – TU Vienna

(summer semester) – Master's Thesis. In any other situations (due to prolonged illness, etc.) a student cannot directly progress to the next university, the student has to wait for 1 year. At this point the mobility challenge for the students has been very positively solved. Initial concerns how this constant moving (from Munich to Vienna to Dresden) may be problematic have proven to be less complicated. The current students seem to manage fine with being at a different place every semester.

2.8. Interaction with the professional socio-economic/scientific sectors

In the Cartography MSc students interact with the industry or governmental organizations (associated partners) within guest lectures, on site visits to companies and agencies, during student projects or within internships. Thus students get an insight into companies and agencies, achieve knowledge and gain valuable advantages by building up a network to potential employees.

Guest lecturers respectively invited lecturers are given for instance by cartographic companies (Cartography Huber), agencies (Austrian Federal Agency for Surveying and Metrology), companies in the geo business (Nokia) and academic experts (Prof. Cartwright, Australia; Prof. Van de Weghe, Belgium, Dr. George Carhart, USA, Dr. Jan Kropacek, Germany).

Excursions are organized e.g. to ESRI-Germany in Kranzberg, to the Bavarian state agency for surveying (LVG), to the German Aerospace Establishment's (DLR's) Center for Crisis Information (ZKI) as well as its French equivalent, SERTIT in Strasbourg.

2.9. Job Perspectives

The qualification "Master of Science (M.Sc.) in Cartography" opens up professional prospects for students both in the private sector and also in research. Potential employers in the research field are primarily research institutes and universities, but also research departments in companies. In the private sector, potential employers are companies that work with geo-data and cartographic publishing houses and public authorities across the world. Cartographic employment areas have been published by Fraser (2005). Some recent events have shown the importance of geospatial services, when Apple released the Iphone in the summer 2012 5. The mapping and routing functionalities, previously provided by Google, had changed. The quality and the data content in the updated system were of somewhat lower quality than the previous services. Within the cartographic research community this was discussed as a "map war" between two competing systems providing maps and extended map functionalities. Obviously Apple

has underestimated the work and expertise that is required to build up a high quality spatial information service. We believe it is safe to say that future applications require expertise within this field that has been currently done "on the side". Master graduates in the field of cartography and relating fields will profit from this development in terms that their expertise like will be required increasingly in the future.

3. Participant statistics

3.1. Target groups and target figure

The aim is to accept 15-25 students every year. This target figure is based on the available resources and on the desire to offer the students the best possible individual supervision. The predicted number of applicants is around 50-100 students and rising. The study program targets qualified university graduates from across the world that have a Bachelor degree or similar qualification in the field of cartography, informatics, geodesy, geoinformatics, geoscience, natural science or environment science.

3.2. Applications & participant statistics

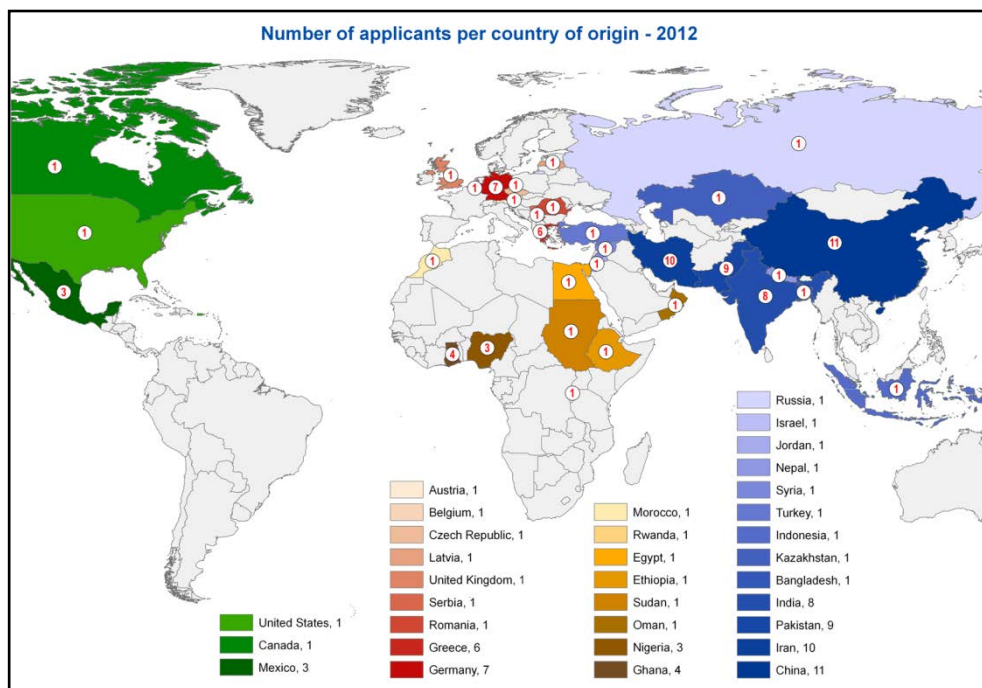


Figure 2. Intake 2012: number of applicants per country

Application overview	Intake 2011	Intake 2012
Application requests:	145	320
Applications in total:	48	86
- from how many different countries:	28	33
- number of female applicants:	15	29
- number of male applicants:	33	53
Admitted applications:	25	31
Finally enrolled students:	14	21
- from how many different countries:	10	12
- number of female students:	5	15
- number of male students:	9	6

Table 1. Applications details of Intake 2011 and Intake 21012

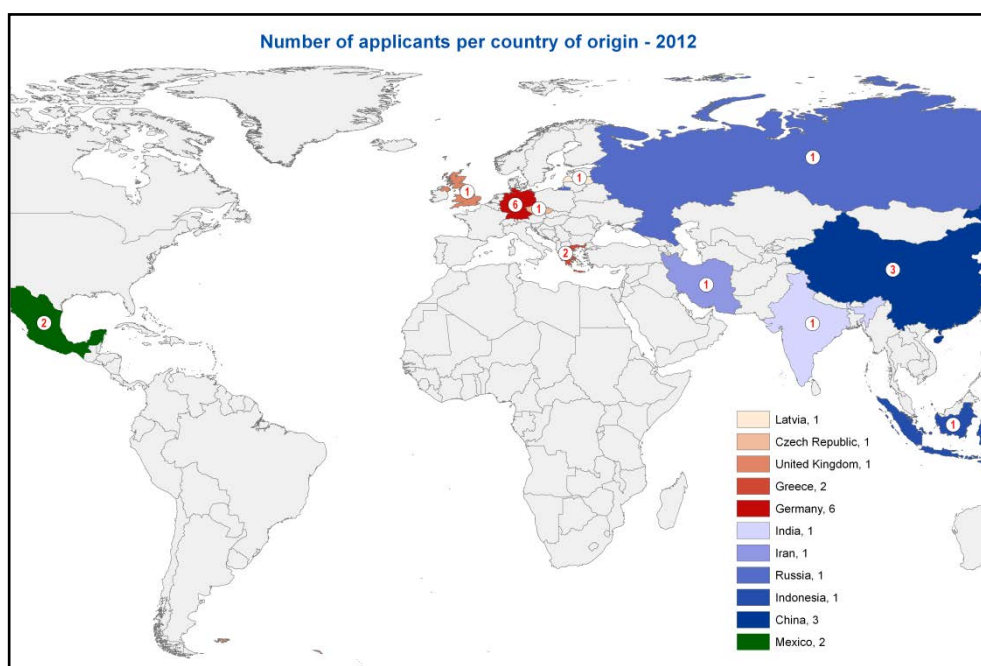


Figure 3. Intake 2012: number of enrolled students per country

Figure 2 illustrates the number of applicants per country and Figure 3 shows the number of finally enrolled students per country for the Intake 2012. For the Intake 2011 in total 48 applications had been received and finally 14 of altogether 25 admitted students started the program. For the Intake 2012 in total 86 applications had been received and finally 21 of altogether 31 admitted students started the program. It is to be mentioned that in 2011 Intake 1/3 are female students whereas in 2012 Intake 3/4 are female students. An overview about the applications in 2011 and 2012 is provided in Table 1.

Cartography as an interdisciplinary field interacts with diverse areas when Geodata have to be analyzed respectively visualized. As explained before the first semester of our Master aims to harmonize different study backgrounds of our students. Figure 4 illustrates the study backgrounds distribution of our students (Intake 2011 and Intake 2012 together).

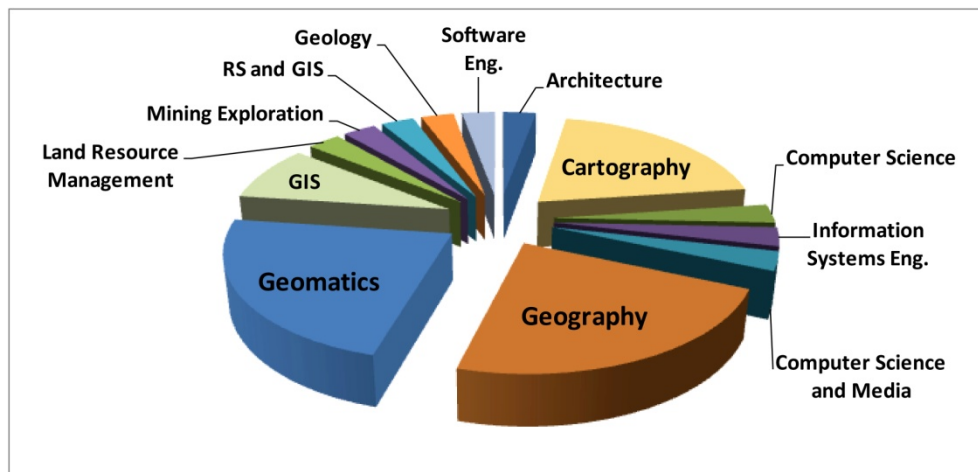


Figure 4. Students study background, students of Intake 2011 & 2012

4. Student feedback

With the Intake 2011 at the end of the first and of the second semester a feedback meeting was held at TU Munich and at TU Vienna. Overall, the students gave positive feedback, but also valuable suggestions for course improvement. Furthermore students found it interesting to see the different approach to cartography and to teaching in comparison of TU Munich and TU Vienna. They also mentioned that some courses were a surprise for them and they were not able to see their relevance for cartography in the beginning but in the end of the semester they were happy to have the knowledge as they see it as important now. Nevertheless, students said that

after a quite theoretical semester in Munich with many examinations they were happy to see that the program in Vienna consists of many practical parts. These practical aspects are then – including the necessary theoretical bases – deepened during the third semester at TU Dresden. In November 2012 an online questionnaire was performed. Results are displayed in **Table 2**. All students furthermore were very satisfied with the program coordination and supervision. Furthermore all students would recommend the program to their fellow students.








How satisfied are you with the teaching quality?		
extremely satisfied		0 (0 %)
very satisfied		6 (43 %)
half satisfied		8 (57 %)
only a bit satisfied		0 (0 %)
not satisfied		0 (0 %)
How satisfied are you with the coordination and supervision?		
extremely satisfied		5 (36 %)
very satisfied		8 (57 %)
half satisfied		1 (7 %)
only a bit satisfied		0 (0 %)
not satisfied		0 (0 %)
How satisfied are you in general, participating in the program?		
extremely satisfied		0 (0 %)
very satisfied		10 (71 %)
half satisfied		4 (29 %)
only a bit satisfied		0 (0 %)
not satisfied		0 (0 %)

Table 2: Results of the student's questionnaire

5. Specific program experiences – a first conclusion

One of the main difficulties was to establish the joint degree, awarded by all three participating universities. After intensive discussions and collaborations during 2008 and 2010, finally in 2011 TUM, TU Vienna and TU Dresden signed the common cooperation agreement for the joint MSc in Cartography. We tried to develop one study regulation for the program which balances all university specific rules of each location, but it was not practi-

cable. Finally we have three study regulations, each one for all modules and examinations at each university.

5.1. Experiences at TUM

From a teacher's point of view, the integration of the Master students into the structure of the department has been very positive. As English is increasingly used as a teaching language on the Master level, the "new" international students are very beneficial. This way the local, or more generally the German students see the benefit of giving lectures and exercises in the English language. Without this very international Master program it would be more difficult to convince German students of the benefit of English as a teaching language for cartography.

On the other side to some extent teachers had been active in integrating the international students into ongoing courses. We may find a tendency that the international MSc Cartography students form a very close and active sub-group within the department's courses. To some extent we as teachers and lecturers have to actively encourage the international students to mingle with the German students from the classic "Geodesy and Geoinformation" Master program. This can be achieved via joined exercises and excursions. Perhaps here is still room for improvement.

5.2. Experiences at TU Vienna

As all courses at TU Vienna were open for local and international students, we had positive effects on the overall course quality in those courses that were only booked by a small number of local students in the past, as some degree of positive competition among the students developed. For other courses the total number of students became too high for hands-on on-site classes. We overcame this problem by introducing groups and using e-learning methods. Finally, local students also benefited from the English language courses as they not only had to talk English in class but also with the other students for group works. To foster this effect and also to introduce benefits for the international students, it might be an interesting idea for the future, to mildly force more interaction between local and international students.

5.3. Experiences at TU Dresden

The 10-day fieldwork training in September, prior to the classroom lectures beginning in October, clearly showed the urgent necessity to carry out such an outdoor course. The majority of the students does not possess sufficient fieldwork experiences in non-urban terrain. An adequate sensibilisation regarding general environmental, landscape-ecological and landscape-genetic aspects serves the purpose of deepening the students' understand-

ing of relief representation and various types of thematic maps. Addressing landforms and identifying landmarks for orientation is for several of them a novel experience. Here, the Alps serve as a perfect outdoor training site. Lectures given during day-hikes convey first-hand information and sensation. A one-day orienteering event with a questionnaire full of landscape-related questions allows the students to check their capabilities in the field.

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